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(54) **CYLINDER HEAD ROCKER ARM STAND REPAIR AND PROCESS**

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F02F 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **123/193.5**; 123/90.39

(58) **Field of Classification Search**
USPC 123/193.5, 90.39–90.47
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,469,489	A	10/1923	Manville	
2,287,182	A	6/1942	Leake	
4,086,887	A	5/1978	Schoonover et al.	
4,655,177	A	4/1987	Wells et al.	
4,718,379	A	1/1988	Clark	
5,095,861	A *	3/1992	Dove, Jr.	123/90.39
5,636,600	A	6/1997	Sweetland et al.	
5,711,260	A	1/1998	Aupperle et al.	
5,970,932	A *	10/1999	Richardson et al.	123/90.36
6,230,676	B1	5/2001	Pryba et al.	
6,267,090	B1	7/2001	Schneider	
6,293,238	B1	9/2001	Harmon	
6,557,507	B2	5/2003	Rosenbush et al.	
7,409,939	B2	8/2008	Hughes et al.	
8,251,038	B2 *	8/2012	Bach et al.	123/193.5
2003/0079708	A1 *	5/2003	Bruener et al.	123/193.5
2005/0022768	A1 *	2/2005	Tores et al.	123/90.41
2012/0017862	A1 *	1/2012	Bach et al.	123/90.39

FOREIGN PATENT DOCUMENTS

JP	06206129	7/1994
JP	2007192103	8/2007
JP	2008057505	3/2008
KR	2019980040915	9/1998
KR	2019990030522	7/1999

* cited by examiner

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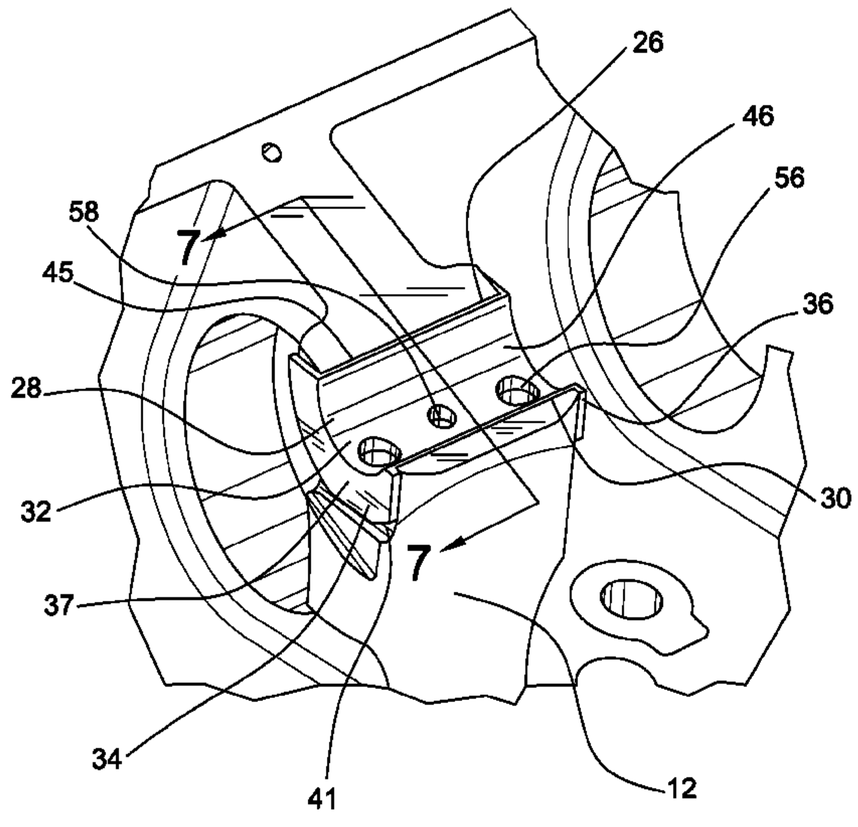
(57) **ABSTRACT**

A process for remanufacturing a cylinder head that includes a worn or damaged rocker arm stand adapted to receive a rocker shaft to which at least one rocker arm is mounted, the steps including machining a channel in a surface of the worn or damaged rocker arm stand, securing an insert into the channel, and machining the insert to form a remanufactured inner facing surface. The remanufactured cylinder head includes at least one rocker arm stand that has a machined channel with a remanufactured insert secured therein, the rocker shaft being disposed adjacent the inner facing surface, not the rocker arm stand.

20 Claims, 7 Drawing Sheets



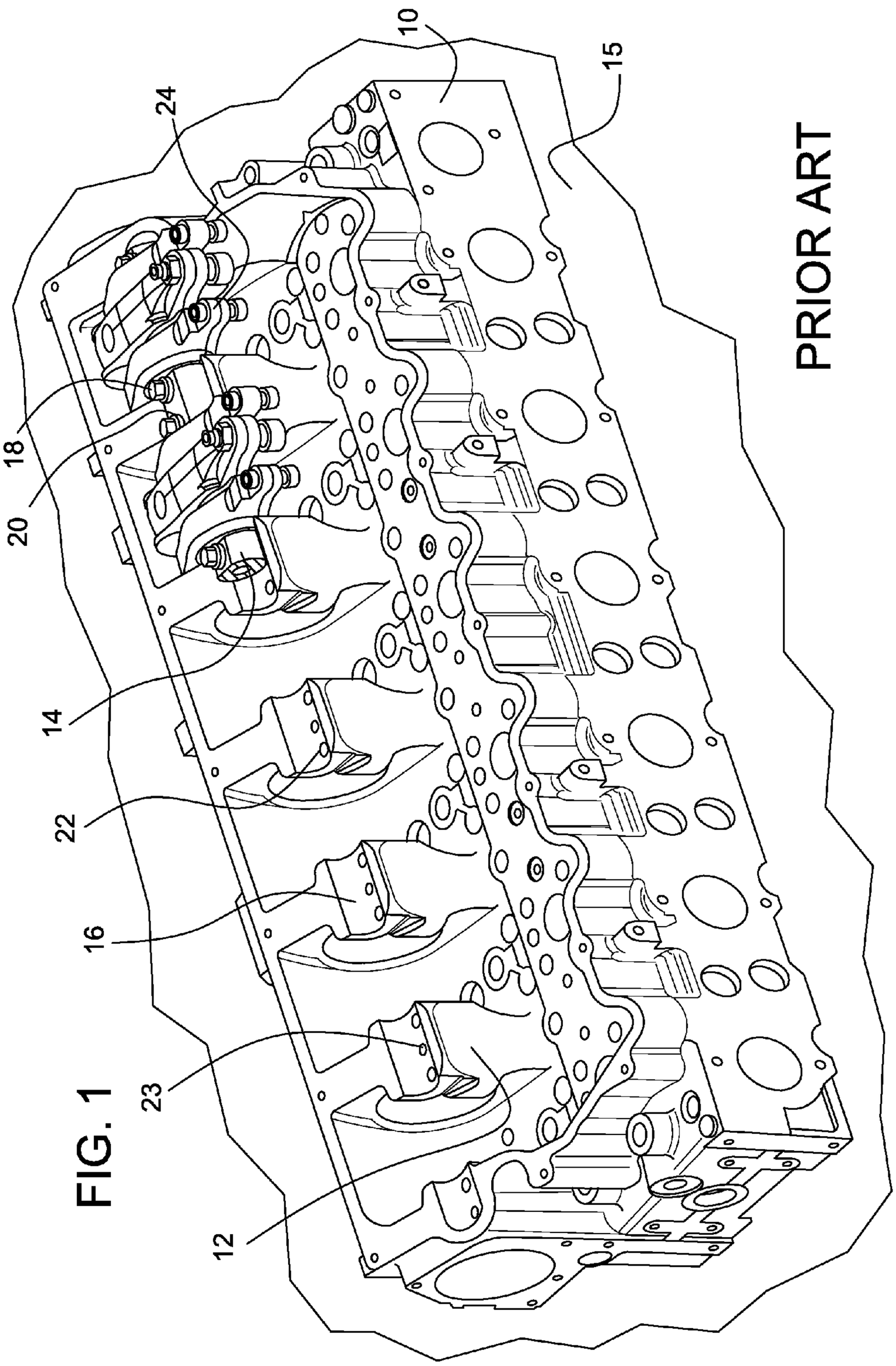


FIG. 1

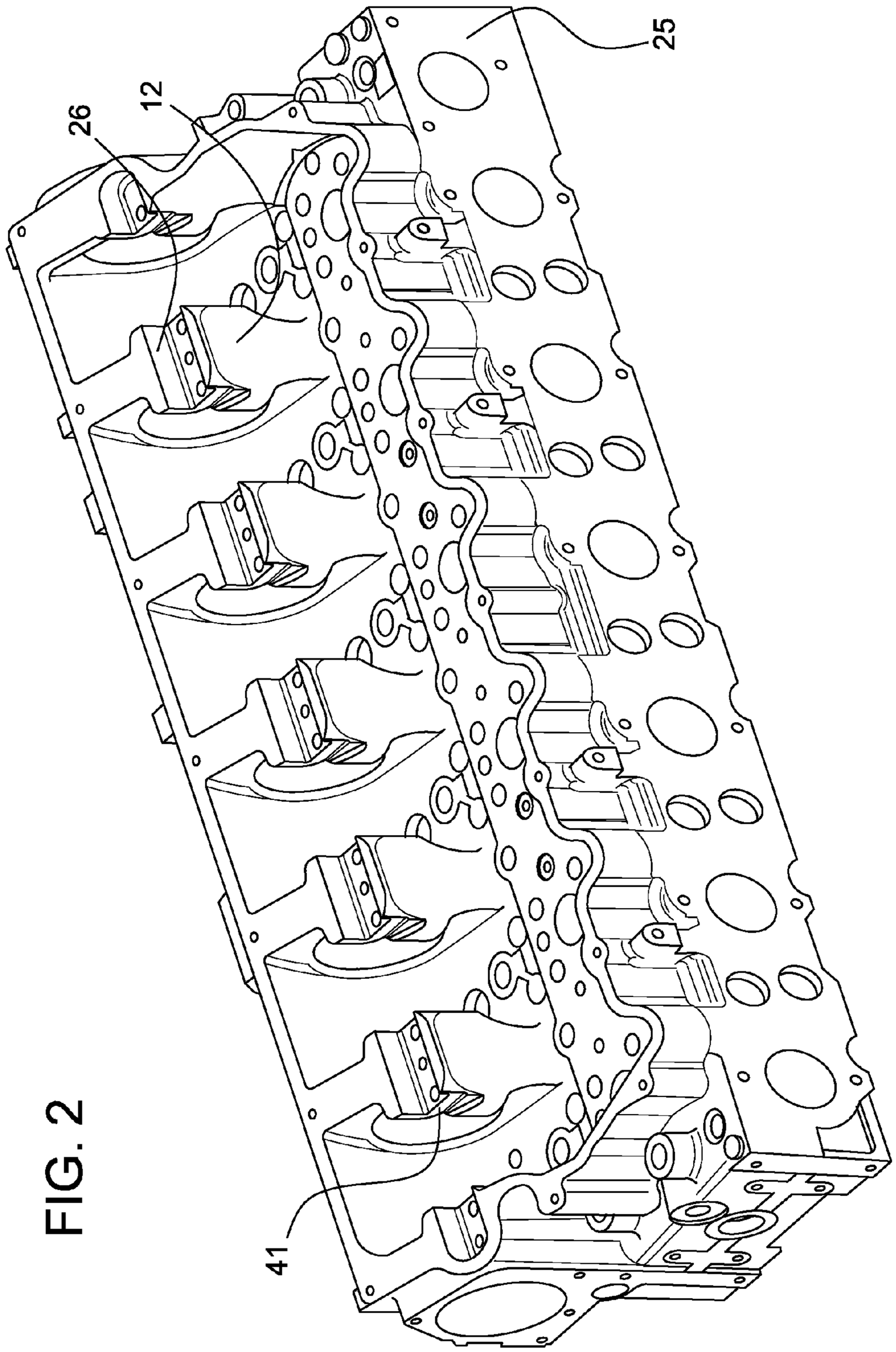


FIG. 2

FIG. 3

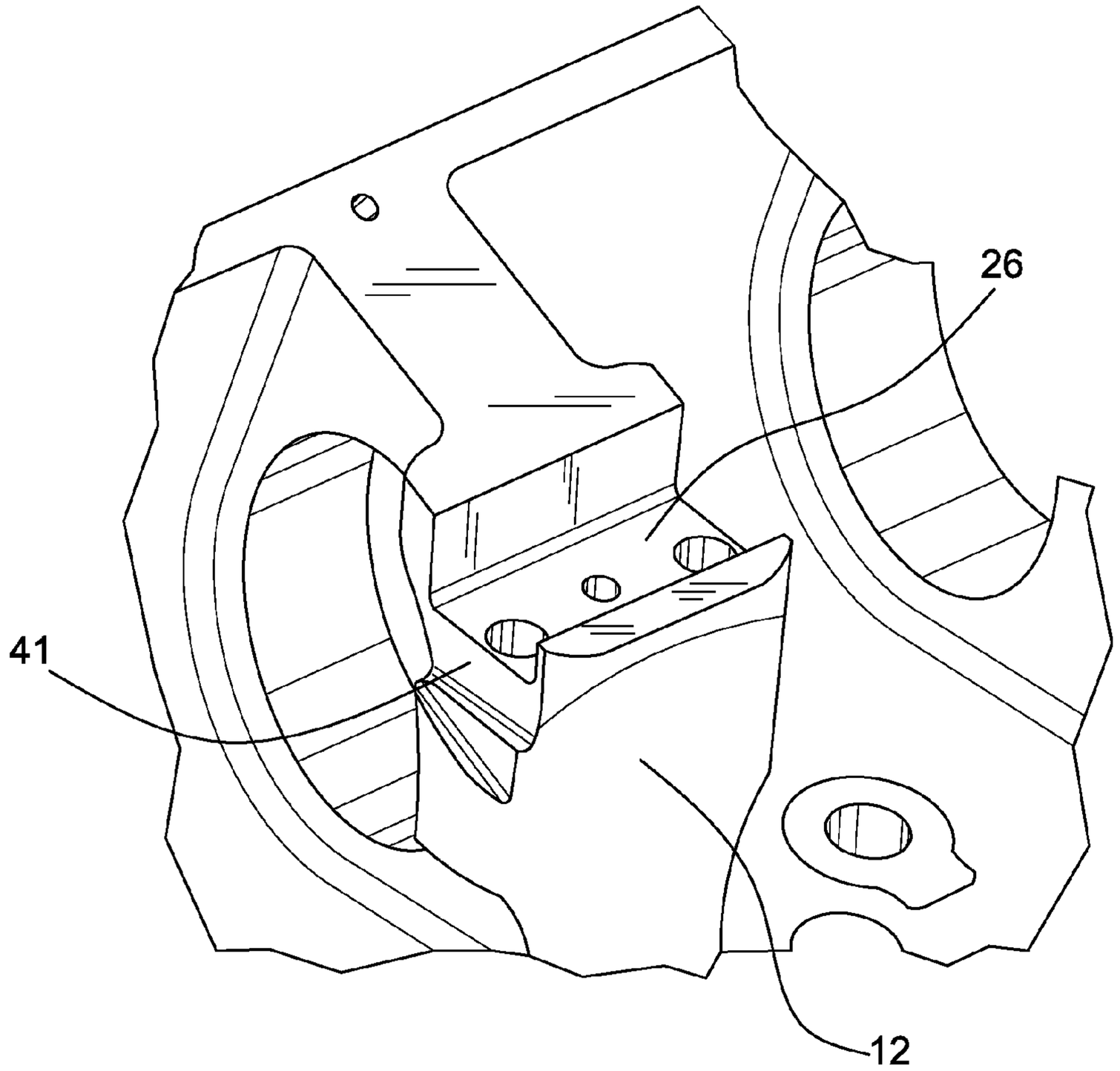


FIG. 4

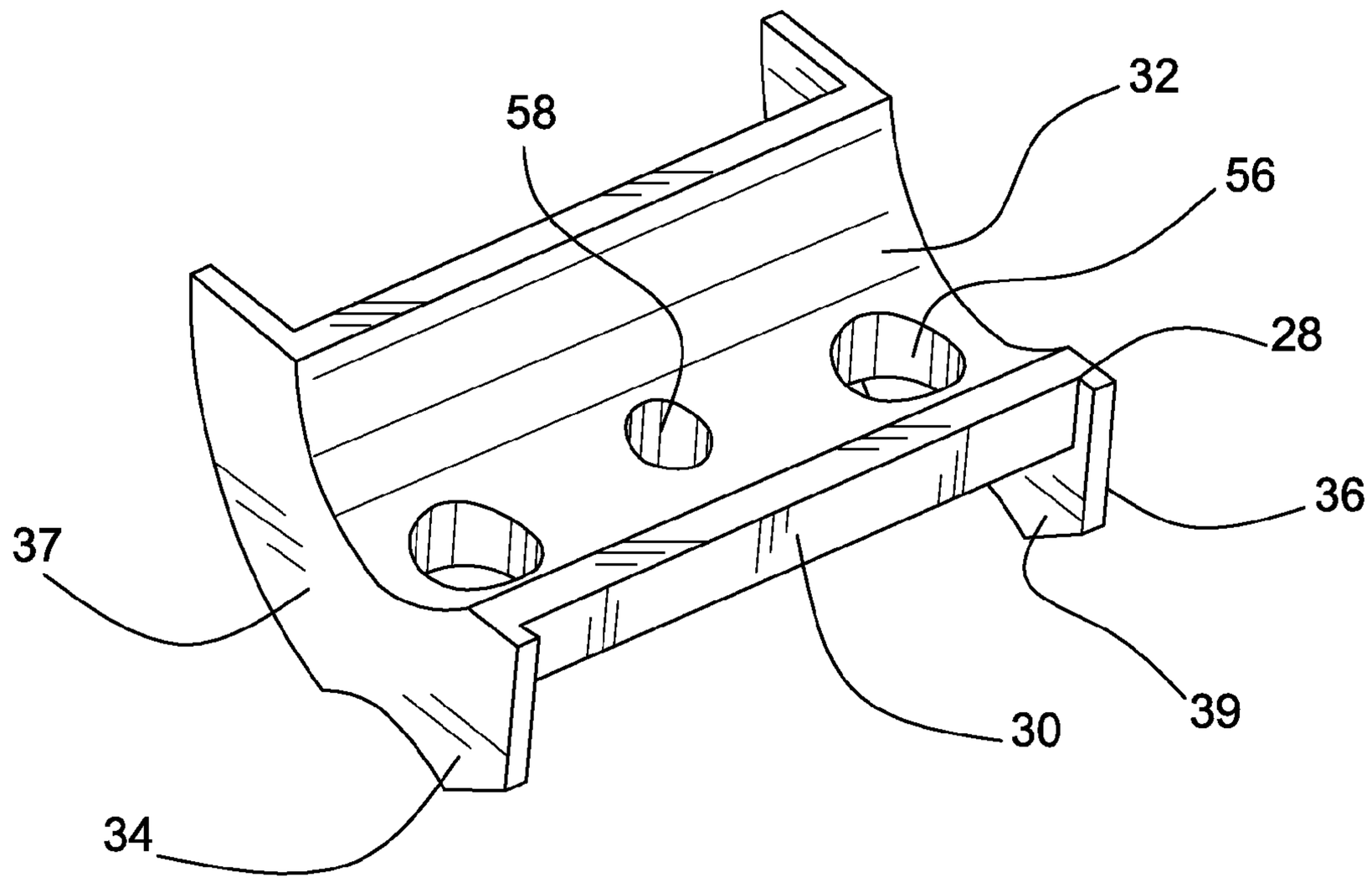
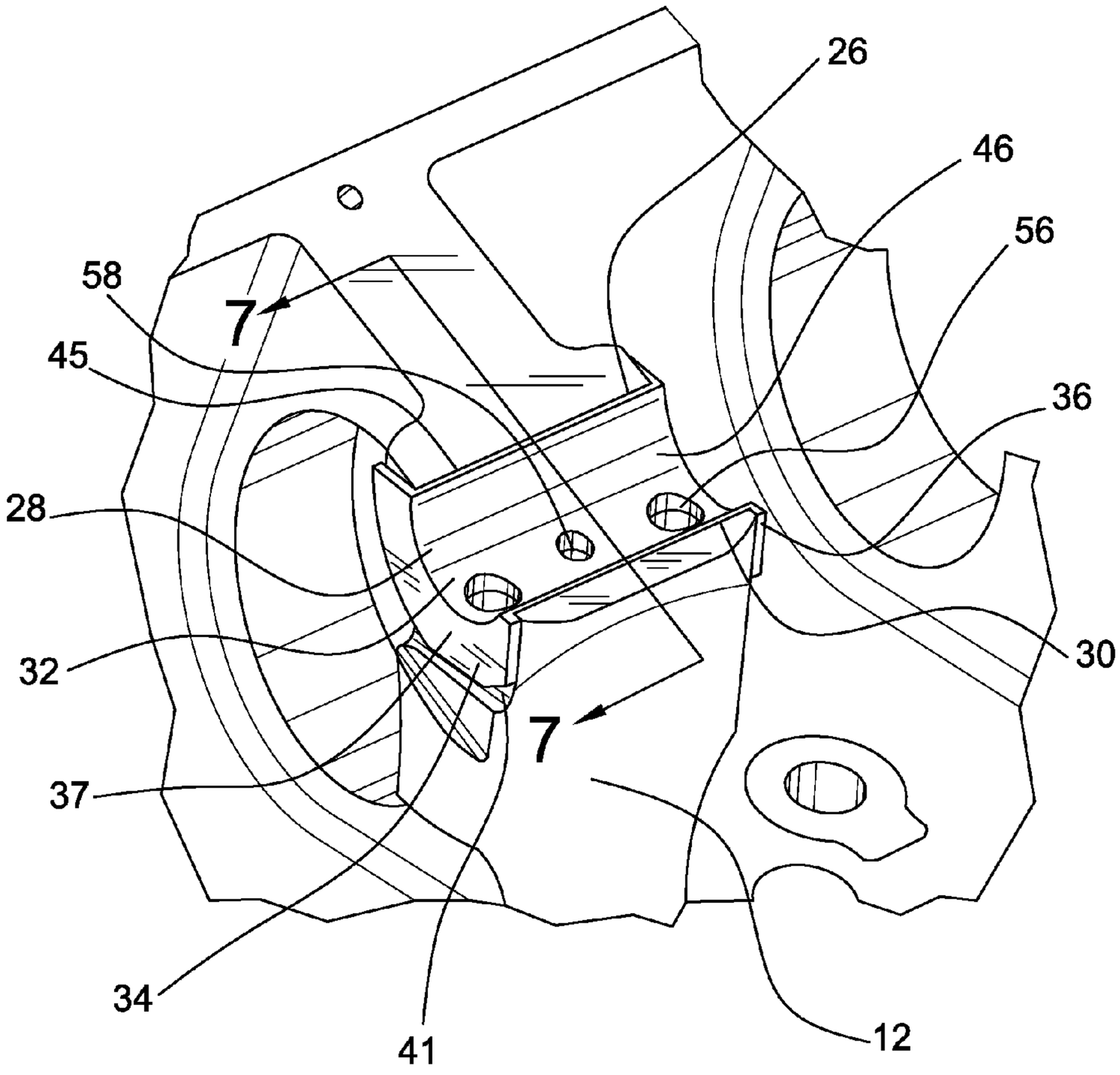


FIG. 5



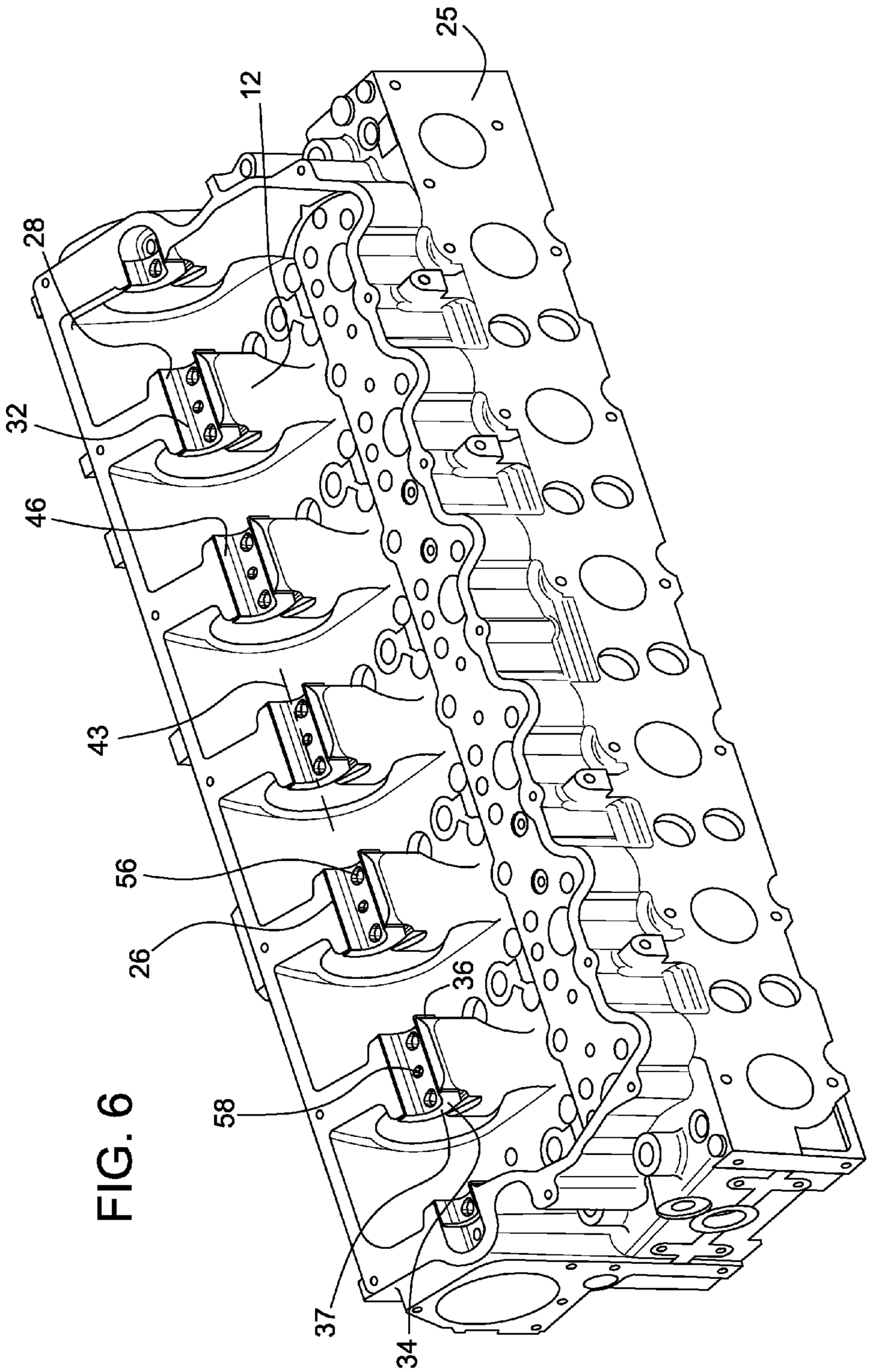
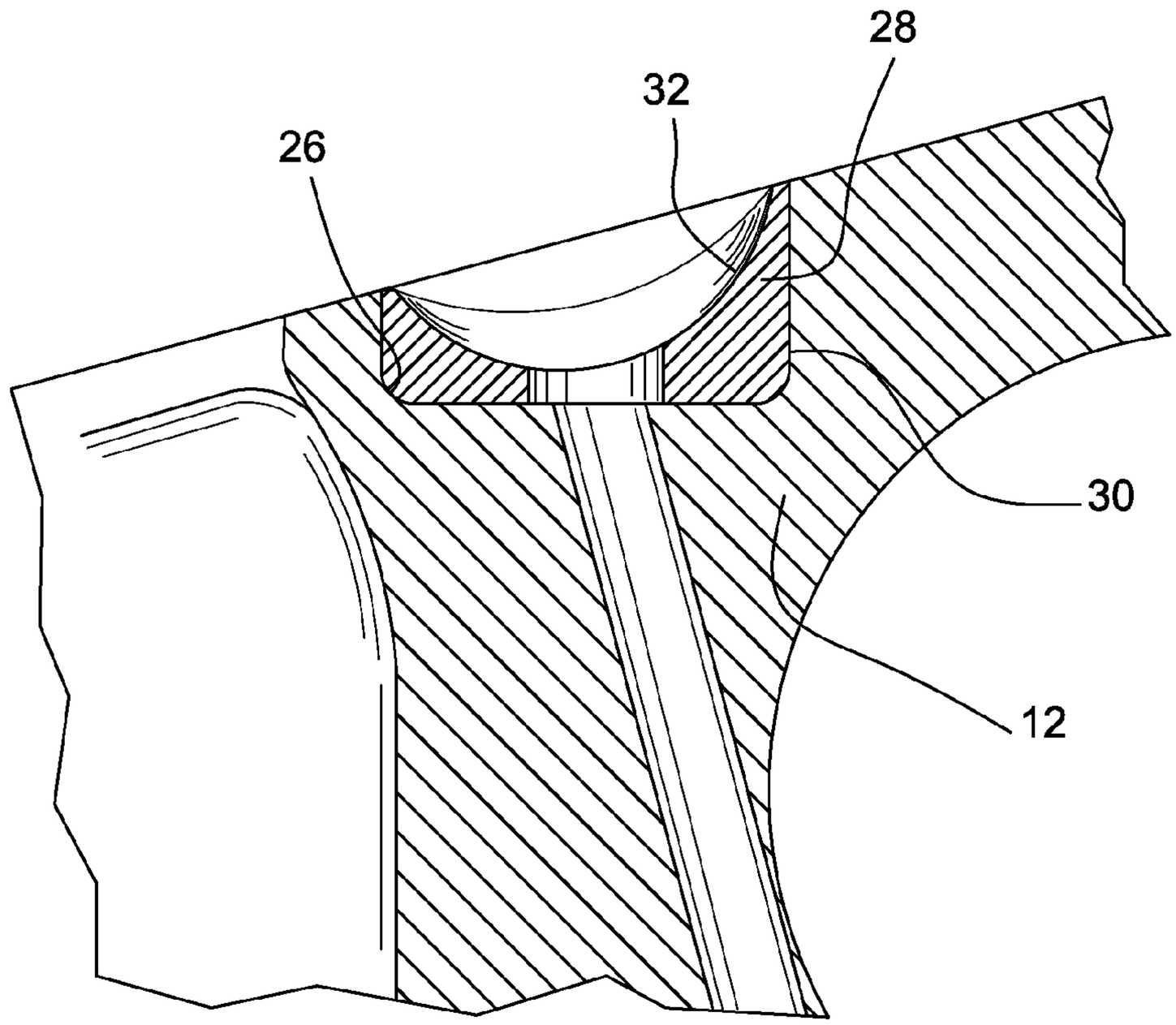


FIG. 6

FIG. 7



CYLINDER HEAD ROCKER ARM STAND REPAIR AND PROCESS

TECHNICAL FIELD

This patent disclosure relates generally to internal combustion engines and, more particularly to a remanufactured cylinder head and a process for remanufacturing a cylinder head for an internal combustion engine.

BACKGROUND

Internal combustion engines, such as multi-cylinder diesel engines, typically include a crankshaft, a camshaft and a rocker arm shaft. The crankshaft is connected with a plurality of piston rods, which in turn are connected with a plurality of corresponding pistons. Reciprocating movement of the pistons within corresponding combustion cylinders causes rotation of the crankshaft.

Generally, the crankshaft is interconnected with the camshaft via a gear set and thereby rotatably drives the camshaft during operation. The camshaft includes a plurality of cams, with each cam being associated with an inlet valve, and an exhaust valve or a fuel injector valve. More particularly, the rocker arm shaft carries a plurality of rocker arms, with each rocker arm having a roller follower, which engages a corresponding cam on the camshaft. Rotation of the camshaft causes oscillatory pivotal movement of the rocker arms about the rocker arm shaft.

In overhead cam engines, rocker arm stands typically are built into the cylinder head casting. The rocker arm shaft it then secured to the stands, the rocker arms pivoting around the stationary rocker arm shaft. Although the rocker arms pivot through a relatively small pivoting angle about the stationary rocker arm shaft, this pivoting may not be sufficient to allow the formation of a hydrodynamic oil film between the rocker arms and the rocker arm shaft. As a result, the friction between the rocker arms and the rocker arm shaft may be relatively high, causing increased wear or spalling between the rocker arms and the rocker arm shaft. Additionally, the movement of the rocker arm shaft and rocker arms may likewise cause damage to the rocker arm stands themselves. Excessive wear can cause inefficient operation of the engine, necessitating replacement of the entire cylinder head casting.

In order to minimize wear, various arrangements have been proposed to increase lubrication and/or reduce friction between the rocker arms and the rocker arm shaft. These proposals are often not entirely effective, or are of relatively high cost to facilitate. For example, it is known to oscillate a rocker arm shaft through a small rotational angle using a rack and pinion arrangement in order to change the eccentricity of the rocker arms relative to the rocker arm shaft. The arrangement disclosed in U.S. Pat. No. 4,718,379 to Clark provides a roller bearing pivot assembly between the shaft and the rocker arm. The retrofit roller bearing pivot assembly about the top of a spacer member, which forms the rocker arm shaft, the assembly extending along the sides of the spacer member. Of these proposals, however, neither repairs prior damage nor wear.

The present disclosure is directed to overcoming one or more of the problems as set forth above.

SUMMARY

The disclosure describes, in one aspect, a remanufactured cylinder head for an internal combustion engine. The cylinder head, which is adapted to receive a rocker arm shaft to which at least one rocker arm is mounted, includes at least one rocker arm stand having a channel in which an insert is secured. The insert has an inner facing surface for receiving the rocker arm shaft. The rocker arm shaft is disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

In another aspect, the disclosure describes an internal combustion engine comprising a rocker arm shaft, at least one rocker arm mounted on the rocker arm shaft, and a cylinder head. The cylinder head includes at least one rocker arm stand having a channel and an insert secured within the channel. The insert has an inner facing surface in which the rocker arm shaft is received, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

In yet another aspect, the disclosure describes a process for remanufacturing a cylinder head including a worn or damaged rocker arm stand that is adapted to receive a rocker arm shaft to which at least one rocker arm is mounted. The process comprises the steps of machining a channel in a surface of the rocker arm stand adapted to be disposed adjacent the rocker arm shaft in the worn or damaged cylinder head, securing an insert into the channel, and machining the insert to form a remanufactured inner facing surface adapted to receive the rocker arm shaft, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

BRIEF DESCRIPTION OF THE DRAWING(S)

FIG. **1** is an isometric view of a prior art cylinder head casting including a plurality of rocker arms and a rocker arm shaft.

FIG. **2** is an isometric view of a cylinder head according to the disclosure.

FIG. **3** is a fragmentary, enlarged isometric view of a machined rocker arm stand of the cylinder head of FIG. **2**.

FIG. **4** is an isometric view of an insert and the machined rocker arm stand of FIG. **3**.

FIG. **5** is an isometric view of the insert and machined rocker arm stand of FIG. **4** with the insert installed.

FIG. **6** is an isometric view of a cylinder head with inserts according to the disclosure.

FIG. **7** is a cross-sectional view of the insert and machined rocker arm stand taken along line **7**-**7** in FIG. **5**.

DETAILED DESCRIPTION

Turning now to FIG. **1**, there is shown a cylinder head **10** having a plurality of upright rocker arm stands **12** that support an elongated rocker arm shaft **14**. The cylinder head **10** may be utilized in an internal combustion engine **15**, such as, for example, an overhead cam engine, which is utilized, for example in a machine. The term "machine" may refer to any machine that performs some type of operation associated with an industry such as mining, construction, farming, transportation, or any other industry known in the art.

The cylinder head **10** may be fabricated by any appropriate method, such as casting or machining. In the illustrated embodiment, the upright rocker arm stands **12** are cast as an integral part of the cylinder head **10** and then machined to provide the desired dimensions of a recessed rocker valley **16** into which the rocker arm shaft **14** is received.

In the illustrated embodiment, the shaft **14** is secured to the rocker arm stands **12** by a plurality of bolts **18** that extend through bores **20** in the shaft **14** and are received in bores **22** in the rocker arm stands **12**, although the shaft may alternately be provided with a defined range of rotation. Lubricant may be supplied to the interface between the shaft **14** and the

rocker arm stands **12** through one or more bores **23** in the rocker arm stands **12**. Rocker arms **24** are provided along the rocker arm shaft **14**. While only a few of the rocker arms **24** are illustrated, rocker arms **24** are typically provided along either side of each rocker arm stand **12**.

Referring to the remainder of the drawings, this disclosure relates to a method of remanufacturing damaged or worn rocker arm stands **12**, and the resulting remanufactured cylinder head **25** and rocker arm stand **12** arrangement, and an insert **28** for use in repairing a rocker arm stand **12** of a cylinder head **10**.

According to a disclosed method, the rocker valley **16** of the damaged or worn rocker arm stand **12** is machined to form a channel **26** adapted to receive the saddle insert **28** (see FIGS. **2-7**). The saddle insert **28** generally includes an outer facing surface **30** contoured to follow the channel **26**, and an inner facing surface **32** that, when the saddle insert **28** is disposed within the channel **26** in the rocker arm stand **12**, is disposed and adapted to receive the rocker arm shaft **14**.

In the illustrated embodiment, the saddle insert **28** additionally includes a pair of wings or flanges **34**, **36** that are disposed along either side of the rocker arm stand **12** when the saddle insert **28** is disposed within the channel **26**. Outer faces **37** of the flanges **34**, **36** are disposed toward the rocker arms **24**, while inner faces **39** of the flanges **34**, **36** are disposed toward side faces **41** of the rocker arm stand **12**. In an embodiment of the saddle insert **28**, the flanges **34**, **36** are substantially rectangular, although they may have an alternate shape. An embodiment of the method may include machining the side faces **41** of the rocker arm stand **12** to provide a complementary fit with the inner face of the flange **34**, **36**. In this way, the flanges **34**, **36** not only assist in positioning the saddle insert **28**, but they rebuild damaged or worn side surfaces of the rocker arm stand **12**. Further, the flanges **34**, **36** may assist in reducing wear at the interface between the saddle insert **28** and the rocker arm stand **12** substantially adjacent the channel **26**.

The side faces **41** may be disposed generally in a plane substantially normal to an axis **43** extending through the rock arm shaft **14**, or at an alternate angle thereto, so long as the side faces **41** allow the saddle insert **28** to slide down over the rocker arm stand **12**. The outer faces **37** of the flanges **34**, **36** will typically be disposed in a plane that extends substantially normal to the axis **43**, so as not to interfere with the movement of the rocker arms **24**, while the inner faces **39** of the flanges **34**, **36** will generally correspond to the angle of the side faces **41** of the rocker arm stand **12**.

According to the disclosed method, a retention substance, such as a retention compound or substance **45**, is disposed along the outer surface **30** of the saddle insert **28** and/or the surface of the channel **26**, and the saddle insert **28** is installed into the channel **26** by way of press fitting or other appropriate assembly method. The retention compound or substance **45** may be a liquid, solid or other form of retention compound or substance, and may be cured or otherwise set.

The inner facing surface **32** of the installed saddle insert **28** is then machined to provide an appropriate rocker valley **46** for receiving and supporting the rocker arm shaft **14**. If necessary, the outer faces **37** of the flanges **34**, **36** may likewise be machined to an appropriate dimension.

While the channel **26** is illustrated as a rectangular structure, those of skill will appreciate that the channel **26** may be of an alternate design, so long as the channel **26** securely receives the saddle insert **28** when installed. Similarly, the saddle insert **28** may be of an alternate design, particularly along its outer surface **30**, so long as it is contoured to follow the adjacent channel **26** and provide a secure fitment when installed.

Returning to FIG. **4**, the saddle insert **28** may also include one or more openings or bores **56** for receiving a bolt **18**, such as is illustrated in FIG. **1**. In this way, the bolt **18** would extend through the bore **20** in the shaft **14** and the bore **56** in the saddle insert **28**, and be received in the bore **22** in the rocker arm stand **12**. The saddle insert **28** may also include one or more openings or bores **58** for the passage of lubricant. In the illustrated embodiment the bore **58** aligns with the corresponding bore **23** in the rocker arm stand **12** visible in FIG. **3**. In this way, in use, lubricant is permitted to pass through the bores **58**, **23** to the interface between the shaft **14** and the saddle insert **28**.

INDUSTRIAL APPLICABILITY

The present disclosure is applicable to a range of cylinder heads, whether cast or machined. The arrangement and/or method may be utilized, for example, in an overhead cam cylinder head casting. An engine including the arrangement may be utilized in a machine, be it a stationary or a movable machine, such as, for example, any machine that performs some type of operation associated with an industry such as mining, construction, farming, transportation, or any other industry known in the art.

The durability of the disclosed arrangement utilized in a cast cylinder head may result in enhanced durability and wear properties when a hardened steel saddle insert is utilized inasmuch as a hardened steel rocker arm shaft would then wear against the hardened steel saddle insert, as opposed to the cast cylinder head.

The disclosed arrangement and/or method may be useful to prolong the life of a machined or cast cylinder head. Accordingly, the arrangement and/or method may result in concomitant savings in part costs as well as labor. The arrangement and/or method may additionally reduce scrap, thus presenting a greener solution to engine repair.

It will be appreciated that the foregoing description provides examples of the disclosed system and technique. However, it is contemplated that other implementations of the disclosure may differ in detail from the foregoing examples. All references to the disclosure or examples thereof are intended to reference the particular example being discussed at that point and are not intended to imply any limitation as to the scope of the disclosure more generally. All language of distinction and disparagement with respect to certain features is intended to indicate a lack of preference for those features, but not to exclude such from the scope of the disclosure entirely unless otherwise indicated.

Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context.

Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

We claim:

1. A remanufactured cylinder head for an internal combustion engine, the cylinder head being adapted to receive a rocker arm shaft to which at least one rocker arm is mounted, the cylinder head comprising: at least one rocker arm stand including at least one side face and an insert secured to the rocker arm stand, the insert including an outer facing surface, at least one flange, and an inner facing surface for receiving the rocker arm shaft, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand, at least a portion of the outer facing surface engaging the rocker arm stand, and the at least one flange disposed toward the rocker arm.

2. The cylinder head of claim **1** further comprising at least one of a retention substance disposed between the insert and the channel or mechanical fasteners.

3. The cylinder head of claim **1** wherein the insert includes opposed flanges disposed along opposite ends of the insert.

4. The cylinder head of claim **1** wherein the outer facing surface is substantially rectangular, and the rocker arm stand includes a channel that is substantially rectangular.

5. The cylinder head of claim **1** wherein the rocker arm stand includes side faces disposed substantially normal to an axis of the rocker arm shaft, and the insert includes flanges that are positioned substantially adjacent the side faces of the rocker arm stand.

6. The cylinder head of claim **5** further comprising a retention substance disposed between the insert and the channel.

7. An internal combustion engine comprising:

a rocker arm shaft,

at least one rocker arm mounted on the rocker arm shaft, and

a cylinder head including at least one rocker arm stand including a substantially U-shaped channel and an insert secured within the channel, the insert including an inner facing surface that receives the rocker arm shaft, and a substantially U-shaped outer facing surface, at least a portion of the outer facing surface engaging the channel, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

8. The internal combustion engine of claim **7** wherein the channel is machined in the rocker arm stand such that the channel is disposed and adapted to receive the insert.

9. The internal combustion engine of claim **7** further comprising a retention substance disposed between the insert and the channel.

10. An internal combustion engine comprising:

a rocker arm shaft,

at least one rocker arm mounted on the rocker arm shaft, and

a cylinder head including at least one rocker arm stand including side faces disposed substantially normal to an axis of the rocker arm shaft, and an insert secured to the rocker arm stand, the insert including an inner facing surface, an outer facing surface, and flanges that are disposed along at least a portion of the side faces of the rocker arm stand, at least a portion of the outer facing surface engaging the rocker arm stand, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

11. The internal combustion engine of claim **10** wherein the rocker arm shaft includes a channel, at least a portion of the outer facing surface engaging the channel.

12. The internal combustion engine of claim **11** wherein the outer facing surface is substantially U-shaped, and the channel is substantially U-shaped.

13. The internal combustion engine of claim **10** further comprising a retention substance disposed between the outer surface and the rocker arm stand.

14. The internal combustion engine of claim **10** further comprising at least one mechanical fastener securing the insert to the rocker arm stand.

15. A remanufactured cylinder head for an internal combustion engine, the cylinder head being adapted to receive a rocker arm shaft to which at least one rocker arm is mounted, the cylinder head comprising: at least one rocker arm stand including a U-shaped channel and an insert secured within the channel, the insert including an inner facing surface for receiving the rocker arm shaft, and a substantially U-shaped outer facing surface, at least a portion of the outer facing surface engaging the channel, the rocker arm shaft being disposed adjacent the inner facing surface, but not adjacent the rocker arm stand.

16. The cylinder head of claim **15** further comprising a retention substance disposed between the insert and the channel.

17. The cylinder head of claim **15** further comprising at least one mechanical fastener securing the insert to the rocker arm stand.

18. The cylinder head of claim **15** wherein the insert includes at least one flange disposed toward the rocker arm.

19. The cylinder head of claim **18** wherein the insert includes opposed flanges disposed along opposite ends of the insert.

20. The cylinder head of claim **15** wherein the rocker arm stand includes side faces disposed substantially normal to an axis of the rocker arm shaft, and the insert includes flanges that are positioned substantially adjacent the side faces of the rocker arm stand.

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